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Risk aversion when gains are likely and unlikely: evidence from a natural experiment with large stakes

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PAVLO BLAVATSKYY and GANNA POGREBNA

RISK AVERSION WHEN GAINS ARE LIKELY AND UNLIKELY: EVIDENCE FROM A NATURAL EXPERIMENT WITH LARGE STAKES

ABSTRACT. In the television show *Deal or No Deal* a contestant is endowed with a sealed box, which potentially contains a large monetary prize. In the course of the show the contestant learns more information about the distribution of possible monetary prizes inside her box. Consider two groups of contestants, who learned that the chances of their boxes containing a large prize are 20% and 80% correspondingly. Contestants in both groups receive qualitatively similar price offers for selling the content of their boxes. If contestants are less risk averse when facing unlikely gains, the price offer is likely to be more frequently rejected in the first group than in the second group. However, the fraction of rejections is virtually identical across two groups. Thus, contestants appear to have identical risk attitudes over (large) gains of low and high probability.

KEY WORDS: risk attitude, risk aversion, risk seeking, natural experiment

JEL CLASSIFICATION: C93, D81

1. INTRODUCTION

Empirical studies find that individuals tend to exhibit a risk-seeking behavior when dealing with risky lotteries that yield positive outcomes with small probability. At the same time, individuals often exhibit risk aversion when faced with lotteries that deliver positive outcomes with moderate or high probability. Historically, one of the first observations in support of this phenomenon was empirical evidence that people simultaneously purchase insurance and public lottery tickets (e.g., Friedman and Savage, 1948). Studies of betting behavior in horse races (e.g., McGlothlin, 1956; Mukhtar, 1977;

Williams and Paton, 1997) also document that individual risk attitudes depend on the nature of risky alternatives. Specifically, the evidence from gambling in horse races suggests that individuals tend to undervalue horses, listed as favorites, and bet on long shots.

The general tendency to prefer less risky alternatives when dealing with probable gains and more risky alternatives when dealing with unlikely gains is reflected in well-known experimental findings of the common consequence effect (e.g., the Allais paradox, Allais, 1953) and the common ratio effect (e.g., Kahneman and Tversky, 1979). Numerous experimental studies documented risk-seeking behavior over gains of low probability and risk aversion over gains of medium and high probability. For example, Cohen et al. (1985) find that 75% (56%) of subjects are risk seeking, i.e., they prefer a lottery yielding a gain with probability $1/6$ ($1/4$) over its expected value for certain. Tversky and Kahneman (1992) show that subjects reveal a higher certainty equivalent than the expected value of a lottery in 78% of cases when probability of a gain is less than 10% and only in 10% of cases when probability of a gain is higher than 50%. Di Mauro and Maffioletti (2004) demonstrate that in the auction setting subjects exhibit risk-seeking behavior when they face a lottery with 3% and 20% probability of a gain, and risk averse behavior when probability of a gain is 50% and 80%.

Studies of risk aversion with large outcomes of low and high probability rely only on hypothetical incentives. Hershey and Schoemaker (1980) find that subjects tend to choose a risky lottery over its expected value when the lottery yields small gain with low probability. However, when a hypothetical gain is large, subjects tend to be risk averse irrespective of whether the probability of a gain is low or high.¹ Using a large representative sample of 3,949 Dutch respondents, Donkers et al. (2001) find that individuals exhibit lower risk aversion when they face large hypothetical gains of low probability.²

In this article, we use the natural laboratory of the Italian (*Affari Tuoi*³) and the British (*Deal or No Deal UK*) versions of the television show *Deal or No Deal* with high monetary incentives to compare risk attitudes when contestants face lotteries with high and low probability of a gain. Initially produced in the Netherlands by the media company Endemol, *Deal or No Deal* has been later exported to 32 countries worldwide. In *Deal or No Deal* a contestant is assigned a sealed box containing an unknown monetary prize. This prize ranges from €0.01 to €500,000 in *Affari Tuoi* and from £0.01 to £250,000 in *Deal or No Deal UK*. In the course of the show, the contestant receives more information about the distribution of possible monetary prizes inside her box and has an opportunity to sell or exchange her box.

We select two groups of contestants—those, who learned that there is a 20% probability of having a large prize inside their boxes, and those, who learned that the corresponding probability is 80%. Contestants in both groups receive qualitatively similar monetary offers for selling the content of their boxes. If *Deal or No Deal* contestants are indeed less risk averse when facing low-probability gains, contestants from the first group should reject such offers significantly more often than contestants from the second group. However, we find that the fraction of contestants who reject the price offer is virtually identical in both groups. This suggests that contestants have identical risk attitudes irrespective of whether lotteries yield positive outcomes with low or high probability.

The remainder of this article is organized as follows. Section 2 presents an overview of the existing natural experiments in the television shows. Section 3 describes the rules of the television shows *Affari Tuoi* and *Deal or No Deal UK*. Section 4 provides basic statistical analysis of the recorded sample of television episodes. Section 5 presents our between-subject design. Section 6 summarizes the results of the natural experiment. Section 7 concludes.

2. NATURAL EXPERIMENTS IN TELEVISION SHOWS

Natural experiments, provided by television shows, are often used in economic research to draw conclusions about various aspects of human behavior. Television shows provide an appealing material for economists, because these shows are often structured as strategic games and well-defined decision problems (Metrick, 1995). For example, Bennett and Hickman (1993) and Berk et al. (1996) employ the natural laboratory of *The Price is Right* to test for the optimal information updating and rational bidding strategies correspondingly. Levitt (2004) and Antonovics et al. (2005) examine discrimination in *The Weakest Link*.

Several studies elicit individual risk attitudes using the data, obtained from the natural experiments. Particularly, Gertner (1993), Metrick (1995), and Beetsma and Schotman (2001) measure individual risk attitudes in the television shows *Card Sharks*, *Jeopardy!*, and *Lingo*, respectively. Due to its simple design and high monetary incentives, *Deal or No Deal* television show has attracted economic researchers as a perfect laboratory for studying individual decision making under risk.

Post et al. (2004) analyze the decisions of contestants in the Belgian, Dutch, and German version of *Deal or No Deal* television show. They assume that all contestants have constant relative risk aversion utility function and either zero wealth or an *ad hoc* wealth of €250,000. Post et al. (2004) also estimate a parametric form of cumulative prospect theory with so-called Quiggin's probability weighting function and an *ad hoc* reference point (either zero, or current monetary offer, or the highest offer).

Post et al. (2004) find that the Arrow–Pratt coefficient of relative risk aversion (estimated for every contestant) sharply decreases after a contestant learns that her box does not contain large prize(s). Since such unlucky contestants are likely to end up facing a gain with small probability, this finding may be interpreted as an indirect evidence of contestants being less risk averse when facing low-probability gains. However, Post

et al. (2004) find that contestants typically face similar distribution of monetary prizes in their recorded sample. Thus, direct testing of whether Belgian, Dutch, or German contestants overvalue (undervalue) the gains of low (high) probability does not seem to be feasible.

Bombardini and Trebbi (2005) analyze the decisions of contestants in *Affari Tuoi* television show. They assume that all contestants have constant relative risk aversion and use instrumental variables to estimate the wealth of every contestant based on their profession and place of residence. Bombardini and Trebbi (2005) also estimate a parametric form of (original) prospect theory without editing phase using power probability weighting function and a zero reference point. They find that contestants are close to risk neutrality, when lotteries involve small outcomes, and that contestants are generally risk averse, when lotteries involve large outcomes.

Using several unique features of the show, Mulino et al. (2006) and De Roos and Sarafidis (2006) measure risk attitudes and study the endowment effect in the Australian version of *Deal or No Deal*. Deck et al. (2006) elicit risk preferences of *Deal or No Deal* contestants using the natural laboratory of the Mexican version of the television show (*Vas o No Vas*). Botti et al. (2006) analyze risk attitudes in *Affari Tuoi* under different theoretical specifications, particularly concentrating on the unobserved heterogeneity of the Italian contestants. Blavatskyy and Pogrebna (2006) analyze exchange offers in *Affari Tuoi* and find that contestants do not appear to be predominantly loss averse when facing lotteries with large outcomes.

Studies on various versions of *Deal or No Deal* mentioned above, with the exception of Blavatskyy and Pogrebna (2006), conduct a parametric estimation of expected utility theory or one of its generalizations. In contrast, this article follows a non-parametric approach. We study risk aversion in a between-subject design without assuming that individual preferences are represented by a specific decision theory

with particular functional forms for utility function, probability weighting function etc.

3. FORMAT OF THE TELEVISION SHOW

Affari Tuoi and *Deal or No Deal UK* are versions of the well-known television show *Deal or No Deal*, aired 6 days a week with the exception of Sunday on the national channels of Italian and British television, respectively. In order to become a contestant, interested candidates have to apply to the countrywide selection centers. In other words, all contestants self-select into the show.⁴

In the Italian version, 20 contestants, representing different administrative regions of Italy, compete for the opportunity to play the game in every television episode. Twenty-two contestants appear in the British version. All contestants receive identical boxes, numbered consecutively from the first to the last.

Each box contains a monetary prize ranging from €0.01 to €500,000 in the Italian version (e.g., Figure 1) and from £0.01 to £250,000 in the British version (e.g., Figure 2).⁵ In the *Affari Tuoi* television show boxes are randomly assigned and sealed by an independent notary company. In *Deal or No Deal UK* prizes are distributed across boxes by an independent adjudicator, however, contestants choose their boxes at random by drawing numbered ping-pong balls.

In both versions of the show contestants know the list of potential prizes but they do not know the content of each box. In *Affari Tuoi* every television episode consists of two phases: the selection phase and the game itself. During the selection phase contestants receive one multiple-choice general knowledge question. The contestant, who is the first to answer this question correctly, is selected to play the game. The remaining contestants (waiting contestants) continue to participate in the next television episode.

The British version of the show does not have a selection phase. The contestant is pre-selected by the producers and,



Figure 1. A typical screenshot with a list of possible prizes at the beginning of the game in *Affari Tuoi*⁶.



Figure 2. A typical screenshot with a list of possible prizes at the beginning of the game in *Deal or No Deal UK*.

therefore, it is quite rare for contestants to wait for more than 30 shows before they receive an opportunity to play the game. However, waiting contestants do not know in advance when they will be selected.

During the game, the contestant keeps her own box and opens the remaining boxes one by one. Once a box is opened, the prize sealed inside is publicly revealed and deleted from the list of possible prizes. The more boxes the contestant opens, the more information she obtains about the distribu-

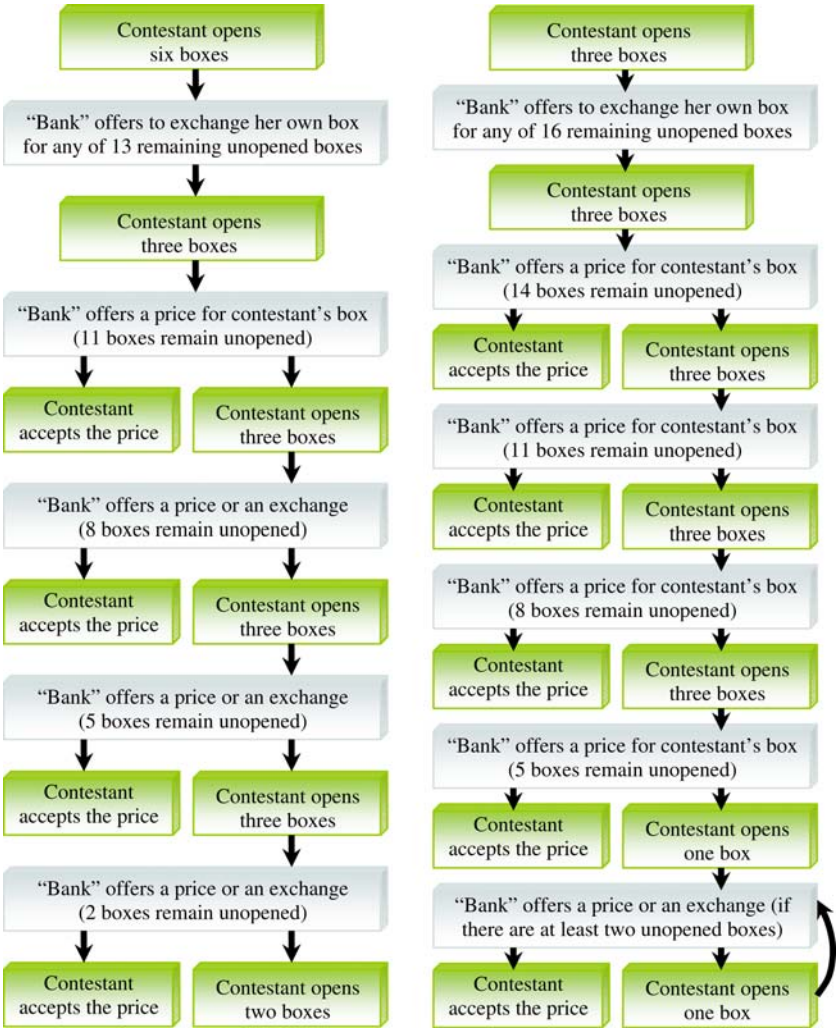


Figure 3. Timing of “bank” offers in *Affari Tuoi* television episodes before February 9, 2006 (left chart) and starting from February 9, 2006 (right chart).

tion of possible prizes inside her own box. The goal of the contestant is to open as many boxes with small prizes as possible to increase her chances of winning a large prize.

After opening several boxes the contestant receives an offer from the “bank.” This offer could be either a monetary price for the content of her box or the possibility to exchange her box for any of the remaining sealed boxes.⁷

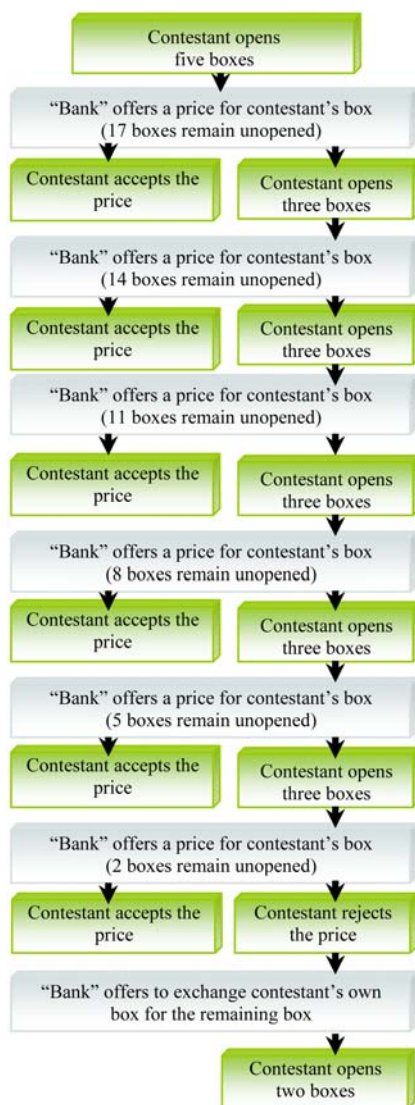


Figure 4. Timing of “bank” offers in *Deal or No Deal* UK television episodes.

Monetary offers are fairly predictable across episodes and follow a general pattern. In the early stages of the game, they are smaller than the expected value of possible prizes. As the game progresses, the gap between the expected value and a monetary offer decreases and often disappears when there are

two unopened boxes left. The game terminates when either the contestant accepts the price offered by the “bank” or when all boxes are opened. In the former case, the content of all remaining unopened boxes is revealed. In the latter case, the contestant leaves with the content of her box, which is opened last. Figures 3 and 4 show the timing of “bank” offers in the Italian and the British versions of the show, respectively.

4. BASIC STATISTICS

Data, analyzed in this article, were derived from two sources. Data on the Italian version of *Deal or No Deal* were transcribed from original RAI Uno broadcasts of *Affari Tuoi* from September 20, 2005 to March 4, 2006. To obtain the data from the British version of the show we used several Internet portals with description of the television episodes and game statistics.⁸ This information was collected by the viewers of *Deal or No Deal* from Channel 4 broadcasts aired from October 31, 2005 to September 21, 2006.

The resulting natural laboratory contained 114 *Affari Tuoi* episodes and 256 *Deal or No Deal UK* episodes. Only one contestant played the game in every episode. In both versions of the show, the contestant, selected to play the game, had to decide on at least one monetary offer.⁹ In the Italian version of the show the contestant also had to decide on at least one exchange offer. We recorded the distribution of all possible prizes that a contestant could potentially win at the moment when she made each decision as well as the prize sealed inside her own box (which was revealed only at the end of the show).

In the beginning of a television episode in both versions of the show, the contestant, selected to play the game, states her name, place of current residence, marital status and, less often, age and occupation. Some personal characteristics of the contestants in *Affari Tuoi* and *Deal or No Deal UK* are briefly summarized in Table I

TABLE I

Personal Characteristics of *Affari Tuoi* and *Deal or No Deal UK* contestants

Personal characteristic	<i>Affari Tuoi</i> (114 contestants)	<i>Deal or No Deal UK</i> (256 contestants)
Male	52 (45.6%)	129 (50.4%)
Female	62 (54.4%)	127 (49.6%)
Married	90 (78.9%)	55 (50.9%) ^a
Single	16 (14.0%)	52 (48.1%) ^a
Divorced	6 (5.3%)	0 (0.0%) ^a
Widowed	2 (1.8%)	1 (0.9%) ^a
Minimum reported age	23	20 ^b
Maximum reported age	70	83 ^b
Average age	46.3	43.9 ^b

^a Marital status data for *Deal or No Deal UK* were available for 108 contestants (42.2%).

^b Age data for *Deal or No Deal UK* were collected for 196 contestants (76.6%).

According to their self-reported data, contestants greatly varied in their age in both versions of the show. However, average age of contestants in *Affari Tuoi* was higher than that of contestants in *Deal or No Deal UK*. In terms of the gender composition, the share of female contestants was greater than that of male contestants in *Affari Tuoi* sample, while in *Deal or No Deal UK* data set men were selected to play the game more often than women. The majority of contestants in both versions of the show were married.

In our *Affari Tuoi* data set, representatives of every Italian region played the game at least once. Contestants from Lombardia played the game most frequently (10 times), while a contestant from Campania played the game only once. In *Deal or No Deal UK*, representatives of 22 administrative regions of the United Kingdom appeared on the show in the “hot seat”. Contestants from Yorkshire played the game most often—eight times (we collected data on administrative

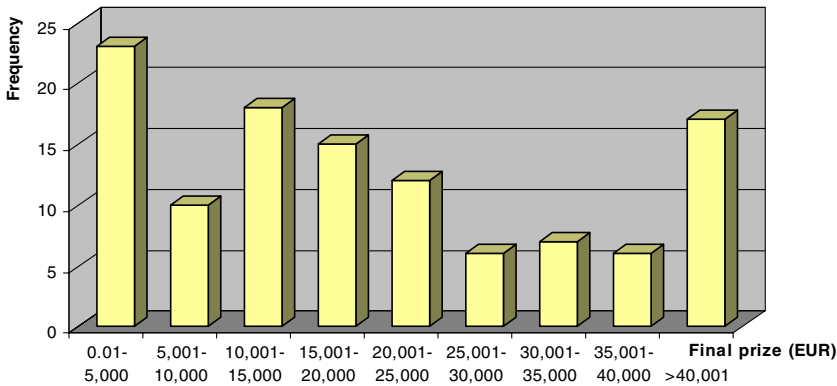


Figure 5. Distribution of final earnings across 114 episodes in *Affari Tuoi*.

regions for 23% of contestants, who played the game in the British version of the show).

Therefore, the demographics, age and personal characteristics of *Affari Tuoi* and *Deal or No Deal UK* contestants make them a more representative subject pool than standard pools, composed primarily of undergraduate students. Moreover, obtaining a similar data set in conventional laboratory conditions would be a highly ambitious project, since it would require a total budget of approximately 9 million euros (e.g., Table II).

Potentially, in *Affari Tuoi* and in *Deal or No Deal UK* any contestant, selected to play the game, can earn a maximum prize of €500,000 and £250,000, respectively. However, the actual earnings of contestants in both versions were significantly lower than the maximum (e.g., Table II). Figures 5 and 6 depict the distribution of final earnings in *Affari Tuoi* and *Deal or No Deal UK* correspondingly.

Table II provides some statistics on earnings of contestants in both versions of the show. Both in *Affari Tuoi* and in *Deal or No Deal UK* men earned on average more money than women. However, irrespective of the gender, average earnings in both versions of the show were significantly lower than the *ex ante* expected value of the prizes from Fig. 1 (€52,295) and Fig. 2 (£25,712) correspondingly.

TABLE II

Summary statistics on earnings of contestants in *Affari Tuoi* and *Deal or No Deal UK*

Category	<i>Affari Tuoi</i> (114 episodes)	<i>Deal or No Deal UK</i> (256 episodes)
Total money paid out by the "bank" to contestants	€3,364,852	£4,102,953
Maximum actual earnings	€250,000	£120,000
Minimum actual earnings	€0.01	£0.01
Average earnings for all contestants	€29,516	£16,027
Median earnings for all contestants	€19,000	£12,200
Standard deviation of earnings for all contestants	€42,120	£16,605
Average earnings for male contestants	€31,582	£16,090
Median earnings for male contestants	€20,000	£12,000
Standard deviation of earnings for male contestants	€48,271	£16,868
Average earnings for female contestants	€27,784	£15,963
Median earnings for female contestants	€17,000	£12,900
Standard deviation of earnings for female contestants	€36,491	£16,400
Average stake in initial box, assigned to contestant	€41,279	£19,838
Median stake in initial box, assigned to contestant	€250	£500
<i>Ex ante</i> expected value of the prizes	€52,295	£25,712

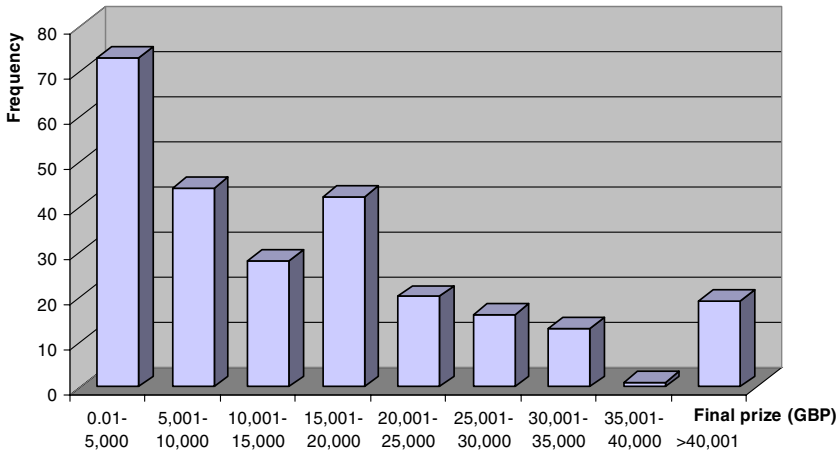


Figure 6. Distribution of final earnings across 256 episodes in *Deal or No Deal UK*.

Furthermore, in both versions of the show average earnings were also lower than the average prize in boxes, initially assigned to contestants who played the game. In both versions of the show the distribution of initial endowments was not significantly different from a uniform distribution ($\chi^2 = 22.49$ and $p = 0.2605$ in *Affari Tuoi* and $\chi^2 = 20.89$ and $p = 0.4656$ in *Deal or No Deal UK*).

5. NATURAL EXPERIMENT

The main idea of our between-subject design is to identify two groups of contestants—those who learned that there is a small chance of a large prize inside their box and those who learned that this chance is high—and to compare the rejection rates for “bank” monetary offers across two groups. In order to select two groups we use the stage of the game when five unopened boxes are left and the probability of receiving each of five possible prizes is 20%.¹⁰ Specifically, contestants in the first group have learned that the chances of a large prize inside their box are one to five. Contestants in the

second group have learned that the corresponding chances are four to five.

In conventional laboratory experiments, which test for risk attitudes across various types of probabilistic distributions, subjects typically face a lottery with only one positive outcome of varied probability (e.g., Cohen et al., 1985). In this natural experiment contestants face lotteries with five positive outcomes. Since we manipulate the probability of receiving a large prize across two groups, we need to provide a definition of a “large prize” for each version of the show. Figures 1 and 2 offer two natural thresholds for distinguishing between large and small prizes. In *Affari Tuoi* €500 is the last “blue” prize, which appears on the left hand side of the prize table (e.g., Figure 1). Furthermore, all prizes below €500 are significantly (at least 10 times) smaller than all prizes above €500. In *Deal or No Deal UK* £750 is the last “blue” prize, which appears on the left-hand side of the prize table (e.g., Figure 2). Thus, we identify a contestant as a member of the first (second) group if after opening 15 or 17 boxes she learns that there is a 20% (80%) probability that the prize inside her box exceeds €500 or £750 respectively.

A natural way to compare risk attitudes across two groups is to contrast the decisions of their members when they are offered the expected value of possible prizes for forgoing the content of their box. However, when five boxes remain unopened, “bank” monetary offers in *Affari Tuoi* are always below the expected value of possible prizes and “bank” offers in *Deal or No Deal UK* are less than actuarially fair in 98.9% of all cases.¹¹

A precise mechanism of setting “bank” monetary offers is not revealed in the show regulations. Bombardini and Trebbi (2005) suggest that offers in *Affari Tuoi* can be modeled as informative signals about the prize sealed inside a contestant’s box that the “bank” sends to the contestant. De Roos and Sarafidis (2006) conduct a regression analysis of “bank” offers in the Australian version of *Deal or No Deal* and find that the variability in “bank” offers is largely explained by the expected value of the remaining prizes but not by the prize

hidden inside a contestant's briefcase. Given these different models of "bank" offers suggested in the literature, we investigate the determinants of "bank" offers in our recorded sample.

Table III presents the results of ordinary least squares (OLS) regression $\ln O = \beta_0 + \beta_1 X_1 + \dots + \beta_{11} X_{11} + \epsilon$ of monetary amounts O that the "bank" offered in exchange for risky lotteries in the Italian and the British versions of the show. Explanatory variables X_1, \dots, X_{11} consist of lottery specific variables (mean, median, and standard deviation of possible prizes, number of possible prizes etc.) and socio-demographic characteristics of the contestants (gender, age, marital status, and region).

The second and the fifth column of Table III demonstrate that around 85% of total variability in monetary offers in *Affari Tuoi* and around 74% of total variability in monetary offers in *Deal or No Deal UK* is explained by the expected value and the number of possible prizes left. In both versions of the show the "bank" makes higher offers when the number of possible prizes decreases, i.e., the game approaches the end. Regression coefficient on the standard deviation of possible prizes is also significant (the more dispersed are the prizes, the lower is the offer). However, regression coefficient of the prize hidden inside a contestant's box is never statistically significant. Thus, there is no information content of "bank" offers and, therefore, it is impossible for contestants to deduce the content of their boxes from the monetary offers that they receive.

Moreover, in both versions of the show contestants in the first group and in the second group receive qualitatively similar monetary offers from the "bank", i.e., the bank does not systematically offer less attractive prices for contestants in one of the groups. Table III shows that "bank" offers do not depend on the probability of receiving a large prize. Contestants are allocated across two groups according to their chances of receiving a large prize, when five boxes remain unopened. Thus, the "bank" does not discriminate between

TABLE III

OLS regression results for “bank” monetary offers in Affari Tuoi ($N=402$) and Deal or No Deal UK ($N=1,300$), dependent variable—natural logarithm of a price offered by the “bank”

Explanatory variables	Regression coefficient (standard error)					
	Affari Tuoi	Deal or No Deal UK				
<i>Lottery specific variables</i>						
Constant	-0.4982* (0.2078)	-0.7219*** (0.2085)	-0.4894 (0.2612)	-0.5606*** (0.1615)	-0.5333*** (0.1581)	-0.5235** (0.1809)
Natural logarithm of expected value of possible prizes	0.9956*** (0.0205)	1.5026*** (0.1184)	1.3828*** (0.1557)	1.0595*** (0.0175)	1.4976*** (0.1186)	1.4424*** (0.1306)
Natural logarithm of a median possible prize		0.0132 (0.0160)	0.0020 (0.0185)		0.0509* (0.0174)	0.0405 (0.0210)
Natural logarithm of standard deviation of possible prizes		-0.5073*** (0.1055)	-0.4118** (0.1331)		-0.4728*** (0.1064)	-0.4277*** (0.1153)
Natural logarithm of the prize hidden inside a contestant's box		0.0044 (0.0063)	0.0022 (0.0064)		0.0064 (0.0042)	0.0064 (0.0043)
Number of possible prizes in a lottery	-0.0931*** (0.0098)	-0.051*** (0.0119)	-0.0549*** (0.0123)	-0.1198*** (0.0045)	-0.1009*** (0.0051)	-0.1016*** (0.0051)

TABLE III
Continued

Explanatory variables	Regression coefficient (standard error)	
	Affari Tuoi	Deal or No Deal UK
Probability of large prize (> €500 in <i>Affari Tuoi</i> , > £750 in <i>Deal or No Deal UK</i>)		
<i>Individual specific variables</i>		
Gender dummy (0 – female, 1 – male)	0.4103 (0.3415)	0.2283 (0.2450)
Self-reported age (in years) or estimate based on physical appearance	0.0678 (0.0601)	–0.0094 (0.0390)
Marital status (0 – married, 1 – single, 2 – divorced, and 3 – widowed)	–0.0022 (0.0027)	0.0002 (0.0015)
Region dummy (0 for the region with the lowest income per capita)	0.0369 (0.0478)	0.0312 (0.0550)
R ²	–0.0043 (0.0050)	0.0003 (0.0030)
Adjusted R ²	0.8567 0.8693	0.7401 0.7535
	0.8560 0.8676	0.7397 0.7525

*Significant at 5% significance level; **Significant at 1% significance level; ***Significant at 0.1% significance level.

contestants in the first group and contestants in the second group when making a monetary offer.

6. RESULTS

Affari Tuoi and *Deal or No Deal UK* contestants are allocated across two groups at random (as a result of pure chance events). Moreover, at a given stage of the game, the representatives of two groups receive qualitatively similar offers that are highly correlated with the expected value of possible prizes. This allows us to formulate our testing hypotheses as follows:

Hypothesis I The fraction of contestants who reject monetary offers from the “bank” is the same in two groups if there are no systematic differences in risk attitudes across two groups.

Hypothesis II The fraction of contestants who reject monetary offers from the “bank” is significantly higher in the first group if its members are less risk averse than the members of the second group.

In our *Affari Tuoi* sample of 114 television episodes, 13 contestants are identified as the members of the first group and 20 contestants—as the members of the second group. In the British data set of 256 television episodes, 23 contestants are classified as the members of the first group and 25 contestants—as the members of the second group. Table IV and V show how many contestants in each group reject/accept a monetary offer when five boxes remain unopened. In both versions of the show, the rejection/acceptance rates are remarkably similar across two groups (p -value for Fisher’s exact probability test is 0.5535 and 0.3490 for *Affari Tuoi* and *Deal or No Deal UK* correspondingly). Therefore, we cannot reject Hypothesis I that risk attitudes are identical across two groups. Apparently, *Deal or No Deal* contestants in Italy and the UK do not become less risk averse when facing large gains of small probability.¹²

TABLE IV

Rejection/acceptance rates for “bank” monetary offers across two groups in *Affari Tuoi*

Group	Number (percentage) of contestants who...	
	Reject “bank” offer	Accept “bank” offer
First group, $\text{prob}(\text{Prize} > \text{€}500) = 1/5$	9 (69.2%)	4 (30.8%)
Second group, $\text{prob}(\text{Prize} > \text{€}500) = 4/5$	13 (65.0%)	7 (35.0%)

TABLE V

Rejection/acceptance rates for “bank” monetary offers across two groups in *Deal or No Deal UK*

Group	Number (percentage) of contestants who...	
	Reject “bank” offer	Accept “bank” offer
First group, $\text{prob}(\text{Prize} > \text{£}750) = 1/5$	16 (69.6%)	7 (30.4%)
Second group, $\text{prob}(\text{Prize} > \text{£}750) = 4/5$	15 (60.0%)	10 (40.0%)

The design of *Affari Tuoi* has slightly changed starting from February 9, 2006. In the television episodes broadcasted before this date, a contestant, who rejects a monetary offer when five boxes remain unopened, receives the next “bank” offer after opening three boxes. In the episodes aired starting from February 9, 2006, such contestant receives the next “bank” offer each time she opens one box (e.g., Figure 3). Thus, the optional value of rejecting a monetary offer for a distribution of five prizes is higher in the episodes starting from February 9, 2006.

One can argue that contestants, who participated in *Affari Tuoi* after the change in design, are more likely to reject monetary offers, when five boxes remain unopened. In our recorded sample, out of 82 contestants, who received a monetary offer for a distribution of five prizes before February 9, 2006, 51 contestants rejected the offer. Starting from February

9, 2006, 14 contestants received a monetary offer when five boxes remained unopened and 11 of them rejected the offer. Although the rejection rate increased from 62.2% to 78.6% after the change in design, this effect does not appear to be statistically significant (p -value for Fisher's exact probability test is 0.1908).

In our recorded sample three contestants from the first group and two contestants from the second group have participated in *Affari Tuoi* starting from February 9, 2006. Thus, if these contestants are indeed more likely to reject the monetary offers for a distribution of five prizes, this effect may be expected to be either similar for both groups or reinforcing the fraction of rejections in the first group.

7. CONCLUSION

This article uses the natural laboratory of the Italian and the British versions of the television show *Deal or No Deal* to test if individuals exhibit lower risk aversion when dealing with risky lotteries that yield (large) gains of low probability. Such lower risk aversion (and even risk seeking behavior) over unlikely gains is persistently documented in numerous experimental studies though evidence in the domain of large gains relies on hypothetical incentives. The natural experiment in *Deal or No Deal* offers a unique opportunity to explore this phenomenon with real incentives (prizes up to half a million euros) and real people (representatives of the Italian and the British population, widely dispersed in terms of age and occupation).

Using a between-subject design and a non-parametric approach, we compare the decisions of two groups of contestants on qualitatively similar price offers for a risky lottery that delivers a large outcome with probability 20% in the first group and 80% in the second group. The fraction of contestants, who reject the monetary offer, is nearly identical across two groups, contrary to the expectation that it should be higher in the first group. This finding suggests that

contestants in the Italian and the British versions of the television show *Deal or No Deal* do not become less risk averse when facing large gains of small probability.

Our results seem to confirm the findings of Hershey and Schoemaker (1980) that individuals are not prone to lower risk aversion when dealing with large improbable gains (e.g., Endnote 1). Thus, a frequently observed phenomenon that people overvalue risky lotteries delivering a relatively small positive outcome with low probability does not appear to hold with risky lotteries yielding a large positive outcome with low probability. Apparently, individuals reveal identical risk attitudes when the probability of a large gain is low and when it is high. This finding provides indirect support for the descriptive validity of expected utility theory for decisions involving lotteries with large outcomes.

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NOTES

1. The fraction of subjects, who prefer a hypothetical gain of 10,000 USD with probability p (zero otherwise) over its expected value for sure, remains nearly identical (27–32%) when the value of p is 0.1%, 1%, 10%, 50%, 90%, and 99%.
2. Only 21% of respondents prefer a 50% chance of receiving 2,000 DFL (zero otherwise) to earning 1,000 DFL for sure. At the same time, 56% of respondents opt for 1% chance of winning 6,000 DFL over 2% chance of receiving 3,000 DFL. At the time of the questionnaire, the exchange rate was 1 DFL \approx 0.50 USD.
3. In translation from Italian “Your Business,” “Your Affairs.”
4. According to Bombardini and Trebbi (2005), Italian contestants are selected from the pool of interested candidates based on two criteria: entertaining appearance and income (wealthy candidates are discarded).
5. At the time of the broadcasts the exchange rate was $\pounds 1 = \text{€}1.47947$.
6. Prize $\text{€}5,000$ was replaced with prize $\text{€}30,000$ starting from January 30, 2006.
7. Official rules of *Affari Tuoi* require the “bank” to offer exchange option at least once in every television episode. Therefore, the first offer that the “bank” makes is always the exchange offer. Before February 9, 2006, the first offer was always made after the contestant opened six boxes. Starting from February 9, 2006, the first offer was made after the contestant opened three boxes. In *Deal or No Deal UK* exchange offer is normally made when there are only two unopened boxes left and the contestant has rejected the last monetary offer.
8. Particularly, a significant portion of the data was compiled from <http://donduk.blogspot.com/2006/06/previous-game-reports.html> and related Internet sources. We have also watched several episodes, available online, including the *Hall of Fame* editions of the show with *Deal or No Deal UK* highlights. We are particularly grateful to Dave Woollin for collecting show statistics and publishing it on the web site <http://www.screwthebanker.com> and to Morten Lau for providing information on personal characteristics of contestants.
9. In our recorded sample, *Affari Tuoi* contestants always rejected a monetary offer when fourteen boxes remained unopened. Only one *Affari Tuoi* contestant accepted a monetary offer ($\text{€}18,000$) when eleven boxes remained unopened (which was his first monetary offer). Ten contestants accepted monetary offer when eight boxes remained unopened. Thirty four contestants accepted their third monetary offer (when five boxes remained unopened). All remaining contestants received from four to seven monetary offers. In *Deal or*

- No Deal UK* all contestants rejected the first two monetary offers, nine contestants accepted the third monetary offer (when 11 boxes remained unopened) and the remaining contestants received from four to seven monetary offers.
10. In the later stage of the game contestants choose between fifty-fifty gambles and the offer of the “bank,” which does not allow for distinguishing between contestants who face likely and unlikely gains. In the earlier stages of the game, there is no sufficient variability in the data (e.g. Endnote 9)
 11. In our *Deal or No Deal UK* sample of observations, the “bank” made four more than actuarially fair offers to contestants. Two of these offers were made when five boxes remained unopened and the other two—when two boxes remained unopened.
 12. We also checked if this conclusion depends on the threshold of what constitutes a “large” prize. Remarkably, the rejection rates across two groups remain nearly identical when the threshold is varied across all possible values between €5 and €30,000 in *Affari Tuoi* and between £1 and £35,000 in *Deal or No Deal UK* (with *p*-values for Fisher’s exact probability test being between 0.1871 and 0.7073). Details of this analysis are available from authors on request.

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